

Z. A.

1

"Detection of ionization of  $\text{Eu}^{++}$  in the phosphor  $\text{SvS-Eu, Sm}$  by the paramagnetic resonance absorption method."

report submitted ~~to~~ The Electrochemical Society, 117th Meeting - Chicago, Ill.,  
1-5 May 60, Symposium on Luminescence.

Physics Institute im. P. N. Lebedev, USSR Academy of Sciences.

FOK, M. V. and VINOKUROV, L. A.

On the Role of a Stimulating Action of Exciting Light in the  
Luminescence Kinetics of the Crystalline Phosphor ZnS-Cu

L. A. Vinokurov and M. V. Fock, P. N. Lebedev Physical Institute, Academy of  
Sciences of the U.S.S.R., and Moscow, U.S.S.R.

It is shown that electrons' release from traps in ZnS-Cu phosphor by an exciting light leads to decrease of the electron concentration on deep traps with increase of excitation intensity. After removing the excitation, the distribution of electrons over traps gradually approaches equilibrium distribution. A flash under the action of an infrared light is determined mainly by release of electrons from deep levels. Therefore the above effects may be detected by measuring the value of the flash under different intensities of afterglow and at various stages of decay.

Report presented at the 117th Meeting of the Electrochemical Society, Chicago,  
1-5 May 1960.

38052 R

S/051/60/009/006/011/018  
E201/E314

24.3500

AUTHORS: Georgobiani, A.N. and Fok, M.V.

TITLE: Principal Peaks of Electroluminescent Brightness Waves

PERIODICAL: Optika i spektroskopiya, 1960, Vol. 9, No. 6, pp. 775 - 781

TEXT: The authors studied ZnS:Cu:Al phosphors with  $10^{-5}$  g-atom/g-mole Cu and  $10^{-4}$  g-atom/g-mole Al. An oscillogram of the electroluminescent brightness (Curve II) is shown together with an oscillogram of the exciting sinusoidal voltage (Curve I) in Fig. 1. The brightness consists of an alternating component, known as the brightness wave, and a constant component denoted by B. The brightness wave has a principal peak, denoted by A, during each half-period of the exciting voltage. Under some conditions a subsidiary peak (B) appears in the brightness wave; this peak is usually weaker than the principal peak. The two peaks are resolved better when the exciting voltage waveform is trapezoidal (Figs. 2, 3). Fig. 4 shows positions of the principal brightness peak as a function of the Card 1/1

Principal Peaks of ....

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E201/E314

amplitude of voltage pulses. Figs. 5, 6, 7 give the "critical voltage" as a function of the front rise-time of voltage pulses (Fig. 5), and as a function of temperatures (Figs. 6 and 7). By the critical voltage the authors mean the voltage which empties even the deepest localization levels in the phosphor. The form of the brightness waves showed that, at high applied voltages, electrons were liberated primarily by electric fields. At low applied voltages electrons were freed by collision ionization (at low temperatures) or by tunnelling through potential barriers (at high temperatures). The optical phonon energies and the energy depths of local levels in ZnS were found from the values of the critical field intensities at which complete liberation of trapped electrons occurred. The optical phonon energies found in this way were in good agreement with values deduced from the vibrational structure of the "edge luminescence" spectrum. The level depths agreed with the donor depths found from the equilibrium density of free electrons in ZnS:Cu crystals.

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Principal Peaks of ....

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There are 7 figures, 2 tables and 13 references: 6 Soviet and 7 non-Soviet.

SUBMITTED: May 26, 1960

Fig. 1:

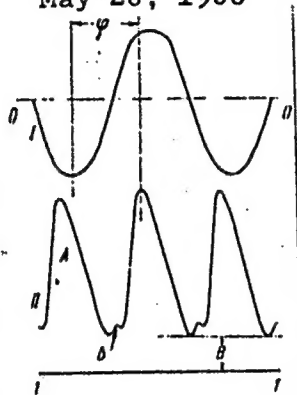


Рис. 1. Осциллограммы яркости электролюминесценции (II) и возбуждающего напряжения (I).

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Fig. 2:



Рис. 2. Осциллограммы яркости электролюминесценции при транзитном возбуждающем напряжении.

see the figures attached hereto  
4

86265

S/053/60/072/003/002/004  
B019/B056

24.3600

AUTHOR:

Fok. M. V.

TITLE:

Electroluminescence

PERIODICAL:

Uspekhi fizicheskikh nauk, 1960, Vol. 72, No. 3,  
pp. 467 - 478

TEXT: In the introduction, the author briefly discusses luminescence in general, mentioning Vavilov and Cherenkov. It is known that that kind of luminescence is described as electroluminescence, in which the luminescent body receives its energy from an electric field. The interrelation between photoluminescence, cathodoluminescence, X-ray-luminescence, and electroluminescence is pointed out, which consists in the luminescent bodies being induced to luminesce by various excitations. The following three questions arise when investigating electroluminescence: 1) Where do the free charges come from which are accelerated in the electric field? 2) In what manner and where do these charges get their energy from the electric field and transmit them to the luminescence centers? 3) At what moment does de-excitation take place, and how is it regulated? For the

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purpose of observing luminescence, the methods suggested by O. V. Losev (Ref.1) and Destriau (Ref.2) are described. The observation of luminescence at p-n-junctions during the current passage is discussed. At the Fizicheskii institut AN SSSR im. P. N. Lebedeva (Institute of Physics of the AS USSR imeni P. N. Lebedev) experiments on zinc sulfides were carried out in the course of the recent five years under the supervision of V. V. Antonova-Romanovskiy at the Laboratoriya luminesentsii im. S. I. Vavilova (Laboratory for Luminescence imeni S. I. Vavilov). At the same time, similar experiments were carried out by T. I. Voznesenskaya, R. M. Medvedova, Ye. I. Panasyuk, and Z. A. Trapeznikova. This work is briefly discussed and among others, V. Ye. Oranovskiy, V. S. Trofimov, A. N. Georgobian, Ye. Ye. Bukke, and L. A. Vinokurov are mentioned. The results of these investigations indicate that electroluminescence actually is a self-regulating process, and that this regulation takes place by changing the electron quantity, which takes part in the luminescence. The considerable increase of brightness with an increase of the applied voltage is connected with an improvement of the conditions for an acceleration of the electrons as well as with the increase of the number of the electrons taking part in the luminescence. Experiments carried

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out on pulverulent electroluminophores, in which knowledge of electroluminescence is still very incomplete, indicate that apart from external, the latter possess also internal electron sources. Herefrom it would follow that brightness as a function of voltage would depend not only on the number of electrons participating in luminescence, but also on the conditions of their acceleration in that crystal range, in which the non-ionized luminescence centers exist. Finally, the importance of studying luminescence for solid body physics on the one hand and for technical engineering on the other is pointed out. B. T. Fedyushin and B. A. Khmelin are mentioned. There are 3 figures and 35 references: 21 Soviet, 4 German, and 7 US. ✓

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FOK, M.V.

Electroluminescence. Usp. fiz. nauk 77 no.3:467-478 N '60.  
(MIRA 16:8)  
(Electroluminescence)

FOK, M.V.; GROZNOVA, V.I., red.; SVESHNIKOV, A.A., tekhn. red.

[Theory of electroluminescent image converters] Teoriia elektroluminescentnykh preobrazovatelei izobrazheniia. Moskva, Izd-vo "Sovetskoe radio," 1961. 50 p. (MIRA 15:2)  
(Photoelectric cells)

GEORGOBIANI, A.N.; FOK, M.V.

Process determining the voltage dependence of the mean brightness  
of electroluminescence. Opt. i spektr. 10 no.2:188-193 F '61.

(MIRA 14:2)

(Luminescence)

VINOKUROV, L.A.; FOK, M.V.

Role of the stimulating action of excitation light in the kinetics  
of the luminescence of the crystal phosphor ZnS-Cu. Opt. i spektr.  
10 no.2:225-231 F 161. (MIRA 14:2)

(Phosphors) (Luminescence)

VINOKUROV, L.A.; FOK, M.V.

Determining the depth of electron traps in ZnS phosphors by  
the flash occurring under the action of infrared light. Opt.1  
spektr. 10 no.3:374-378 Mr '61. (MIRA 14:8)  
(Electrons--Capture) (Infrared rays) (Zinc sulfide)

GEORGOBIANI, A.N.; FOK, M.V.

Dependence of the phase of brightness waves of electroluminescence  
on the parameters of the exciting voltage. Opt.i spektr. 11  
no.1:93-97 J1 '61. (MIRA 14:10)

(luminescence)

24416

S/051/61/011/001/003/006  
E036/E435

24,3500

AUTHOR: Fok, M.V.

TITLE: On the relation between the blue and green  
luminescence bands of ZnS-Cu under electroexcitation

PERIODICAL: Optika i spektroskopiya, 1961, Vol.11, No.1, pp.98-104

TEXT: An approximate theoretical calculation is carried out for the recombination interaction between the blue and green luminescent centres of ZnS-Cu in the presence of an alternating electric field. It is shown that the field markedly complicates the observed phenomena. The author had previously shown that for optical excitation the ratio of the brightness of the blue and green bands is determined by exchange of holes between the blue and green luminescent centres. In the present work the individual crystals are assumed divided into three regions under the action of the field. In the first region there is a space charge, the centres being ionized and the electrons dispersed. In the second region there is hardly any field but there may be many ionized centres created in the preceding half period of the alternating field with which the electrons from the first region recombine. These two regions change places in the succeeding half cycle and  
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S/051/61/011/001/003/006

On the relation between the blue ... E036/E435

give rise to the alternating light component whilst the centre region, in which there is no field and few ionized centres, gives the constant component. The field tends to remove holes from region 1 to the boundaries and inhibits the hole transfer between centres. In the second region the transfer is inhibited by the presence of free electrons. The third region is neglected as its contribution to the total luminescence is small. A system of kinetic equations is set up for the first two regions noting that the final conditions in one region provide the initial conditions when this region alternates with the other region. In region one recombination of electrons with the ionized centres is neglected because of the high electron energy and small effective recombination cross-section; also the hole concentration is taken as constant. In the second region both electron recombination and variation of hole concentration with time must be taken into account, but the electron concentration is assumed constant as they enter from the first region. Expressions can then be obtained for the concentration of ionized blue and green centres as a function of time and the ratio of brightness of the bands calculated in terms

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On the relation between the blue ... E036/E435

of trap parameters. The complicated expression is then simplified for particular cases. Thus for small excitation intensities the ratio of the blue to green intensities is the same as for photo excitation. Inserting parameters previously evaluated from photo excitation experiments (Ref.1: Opt. i spektr., 2, 475, 1957) the expression can be simplified and it is seen that the ratio of intensities at large excitation levels is frequency sensitive but almost independent of excitation level in accordance with the observed behaviour. By comparison with the observed frequency dependence ratios of recombination level parameters are estimated and it is deduced that the presence of the field increases the probability of hole liberation by 5 to 6 orders. The theory cannot, however, be regarded as established because of the approximations, the lack of independent checks on parameters and comparison with experiment has only been effected for one sample. Ye.Ye.Bukke made available some of his experimental results. There are 3 figures and 5 references, all Soviet.

SUBMITTED: August 10, 1960

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29300

S/053/61/075/002/003/007  
B125/B102

24.3500 (1138)

AUTHOR: Fok, M. V.

TITLE: Electroluminescence

PERIODICAL: Uspekhi fizicheskikh nauk, v. 75, no. 2, 1961, 259-261

TEXT: This is a condensed report on a lecture delivered at a seminar meeting of the Fizicheskiy institut im. P. N. Lebedeva AN SSSR (Physics Institute imeni P. N. Lebedev, AS USSR) on March 28, 1961 in memory of S. I. Vavilov. The main part of this lecture was published already earlier (Uspekhi fizicheskikh nauk, v. 72, no. 3, 1960, 467). According to A. N. Georgobiani and M. V. Fok (Optika i spektroskopiya 2, 775 (1960); 10, 187 (1961)), the greatest depth of electron traps involved in ZnS electroluminescence is  $\sim 0.7$  ev. The total number of electrons accumulated in the traps and migrating in the crystal is determined by the tunnel effect at all temperatures. These electrons originate either from the conductive phase (e.g.,  $\text{Cu}_2\text{S}$  on the surface of crystallites) or from the ZnS lattice itself. A strong electric field is capable of liberating both

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29300

S/053/61/075/002/003/007

B125/B102

Electroluminescence

electrons and holes from the traps. According to M. V. Fok (Optika i spektroskopiya 11, 98 (1961)), the frequency dependence of the ratio of the intensity of the blue band to that of the green band is due to the effect of the electric field on recombination. The yield can be increased both by lowering the concentration of radiationless recombination centers and by increasing the probability of hole trapping by luminescence centers. A. M. Bonch-Bruyevich et al. (Optika i spektroskopiya, 11, 87 (1961)) carried out microscopic examinations of brightness waves in blue and green luminescence bands on excitation by square pulses. When the external electric field vanishes, the liberation of electrons from traps and their flow into the region of highly concentrated ionized luminescence centers are interrupted. No such phenomenon occurs in the blue band. This discrepancy, which becomes distinct at pulses shorter than 30  $\mu$ sec, is due to recombination interaction of luminescence centers and can be explained by V. V. Antonov-Romanovskiy's diffusion theory of luminescence (Trudy FIAN 2, vyp. 2-3, 157 (1943)). T. P. Belikova and M. D. Galanin (Izv. AN SSSR, ser. fiz. 25, 364 (1961)) found different attenuation rates of blue and green bands in one and the same interval even if a spark of very short duration was excited by light or alpha particles. There are 7 Soviet references. X

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3909U

S/051/62/013/001/011/019  
E039/E420

24.3500

AUTHORS: Vinokurov, L.A., Fok, M.V.

TITLE: The final stages of the build-up of the blue and green luminescence bands of ZnS-Cu, Cl phosphor

PERIODICAL: Optika i spektroskopiya, v.13, no.1, 1962, 118-123

TEXT: Kinetic equations for the build up of the blue and green luminescence bands in ZnS-Cu are set up and a theory developed on the basis of recombination interactions in luminescence centres. Experiments were performed on the phosphors: ZnS-Cu ( $10^{-6}$  g/g eq), NaCl, ZnS-Cu ( $10^{-6}$  g/g eq), Co ( $10^{-6}$  g/g eq) and four samples of so-called self-activated ZnS phosphors; these rely on a very small amount of Cu impurity for their luminescence. All the data presented refers to measurements at room temperature. Curves are plotted for  $\log (1 - I/I_{\infty})$  against time for the blue and green bands; the distance between them is equal to  $\log \tilde{S}$ , i.e. if  $\tilde{S}$  is constant the curves are parallel. When the excitation proceeds in the presence of infrared light the build up

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E039/E420

The final stages ...

is faster. This is due to the increased probability of freeing electrons.  $\xi$  in three cases has values between 2 and 3.5 which compares with the predicted value. In the case of self activated ZnS the blue and green bands build up at the same rate. It is suggested that this is caused by a weakening of recombination interaction at luminescence centres. Variations in the values of  $\xi$  obtained experimentally are thought to be due to non-uniformity of the phosphors. In general, the build-up of intensity of the blue and green bands follow different laws only in the initial and middle stages, and follow the same law as they approach equilibrium. Further experiments are required using samples prepared under different conditions in order to check the extent of the validity of the calculations for self activated ZnS. There are 4 figures.

SUBMITTED: June 7, 1961

Card 2/2

FOX, M.V.

On the ideal thermal source of light. Opt. i spektr. 13  
no. 4:612-613 0 '62. (MIRA 16:3)  
(Electric lamps)

24.3100  
943500

h2194  
S/051/62/013/004/009/023  
EO39/E491

AUTHORS: Georgobiani, A.N., L'vova, Ye.Yu., Fok, M.V.

TITLE: Absorption of energy in electroluminescence

PERIODICAL: Optika i spektroskopiya, v.13, no.4, 1962, 564-568

TEXT: Measurements are made of the energy absorbed from the electric field applied to an electroluminescent condenser when a sinusoidal exciting voltage is used. These measurements are of importance in the study of processes occurring in luminescent materials and are of practical value in determining the usefulness of luminescent materials as light sources. The current waveform produced by the applied sinusoidal voltage is markedly non-sinusoidal. Instantaneous and average values of the power absorbed are obtained by means of a galvanometer oscillograph method and the average values are compared with values obtained by means of bridge measurements. The accuracy of relative power measurements using the oscillograph is 5% and for absolute values 12%. The minimum value of power measured is 0.008 mW for 50 V applied and the maximum is 100 mW for 1000 V applied. The power waveform is also nonsinusoidal and the nonlinearity increases with Card 1/2

S/051/62/013/004/009/023  
E039/E491

Absorption of energy ...

increasing voltage. The ZnS-Cu,Al as well as the ZnS-Cu from two other sources used all contained chlorine and were in layers 0.03 to 0.04 mm thick. Measurements were made at room temperature using a 50 cycle voltage supply. A  $\Phi \Xi \gamma$  19 (FEU 19) photomultiplier calibrated against a thermopile was used for measuring luminescent energy yields giving a relative accuracy of 6% and an absolute accuracy of 30%. As the voltage is increased, the electroluminescence yield passes through a maximum  $\sim 1\%$  of the absorbed power for voltages of 200 to 275 V, comparable for all the phosphors. The bridge method gives a value of the yield some 25% lower than that determined by the oscillograph method. Maximum light efficiencies are 8 to 9 lumens/watt. The results are compared with theory and good agreement obtained. There are 4 figures.

SUBMITTED: July 21, 1961

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L3499

S/051/62/013/006/019/027

E039/E120

24.2500

AUTHORS: Fok, M.V., and Fridman, S.A.

TITLE: Relation between the rate of decay and the luminescence yield under strong excitation

PERIODICAL: Optika i spektroskopiya, v.13, no.6, 1962, 869-871

TEXT: The introduction of a quenching agent to accelerate the initial phosphorescent decay produces a reduction in the initial intensity. Tests are made to determine a quantitative connection between the rate of decay and the luminescent yield. The initial decay is determined not by recombination but by the transition of electrons from deep traps. This reduction in intensity follows an exponential law:

$$I = I_0 e^{-\frac{\delta_1 W_2 t}{\delta_1 + \delta_2}} \quad (1)$$

where  $\delta_1$  and  $\delta_2$  are the probabilities of trapping electrons in deep and shallow traps. The luminescent yield  $\eta$  from a phosphor with two types of trap is given by:

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Relation between the rate of decay...

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E039/E120

$$\eta = \frac{1}{1 + \frac{\beta_1 W \delta_1}{\beta W_1 \delta} + \frac{\beta_1 W \delta_2}{\beta W_2 \delta}} \quad (2)$$

where  $\beta$  and  $\beta_1$  are recombination coefficients of free electrons and holes;  $\delta$  is the probability of trapping free holes;  $W_1$ ,  $W_2$  and  $W$  are the probabilities of liberating electrons from deep and shallow traps, and holes from ionised luminescence centres. From this the following expression is derived:

$$\frac{\eta}{\eta_0 - \eta} = \left( \frac{\beta W_1 \delta}{\beta_1 W \delta_2} + \frac{W_1}{W_2} \right) \left( \frac{W_2 T^n}{\log n} - 1 \right) \quad (3)$$

where  $\eta_0$  is the value of  $\eta$  at  $\delta = 0$ , i.e. without a quenching agent. This is verified experimentally using zinc sulphide and zinc cadmium sulphides. There are 2 figures.

SUBMITTED: June 4, 1962

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S/048/62/026/004/004/014  
B104/B102

AUTHOR: Fok, M. V.

TITLE: Particularities of luminescence under the action of an electric field

PERIODICAL: Akademiya nauk SSSR. Izvestiya. Seriya fizicheskaya, v. 26, no. 4, 1962, 463 - 467

TEXT: By way of introduction it is noted that thermal radiation and luminescence are statistical phenomena. A heat-emitting body is in thermodynamic equilibrium, but is not when luminescing. This difference makes it impossible to distinguish the various kinds of luminescence from other types of light emission. It is shown that photoluminescence differs from light scattering only in its duration. In the first stage of electroluminescence, excitation energy is taken from the electric field. In the second stage there occurs de-excitation which is called photoluminescence. The electroluminescence of solids has much in common with that of gases. In both cases, electrodes may be the sources of electrons, which may also lie inside the substance. Arc discharges may also take



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Particularities of luminescence...

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B104/B102

place in solids, in which case luminescence is not produced by heat. Space charge, electric field strength, and the course of discharge are of great importance for electroluminescence. The most essential differences between the electroluminescence in gases and that in solid semiconductors are as follows: (1) Solid semiconductors possess two types of highly mobile carriers (holes and electrons), whereas gases have only one type (electrons); (2) fixed charges exist in the traps of solids; (3) free carriers in semiconductors can be produced by the tunnel effect; (4) in semiconductors, radiationless recombination occurs more frequently than in gases. Electroluminescence is classified according to the kind of electric discharge. The results obtained for one object (powdered semiconductor) should be extended to another object (single crystal of the same semiconductor) with great care.

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L:14295-63

EWT(L)/EWG(k)/EDS/EEC(b)-2

AFFTC/ASD/ESD-3

Fz-4

AT/IJP(G)

ACCESSION NR: AP3001263

AUTHOR: Fok, M. V.

3/0181/63/005/006/1489/1495

TITLE: Width of the forbidden band and the effective ionic charge in the crystal lattice of ZnS

SOURCE: Fizika tverdogo tela, v. 5, no. 6, 1963, 1489-1495

TOPIC TAGS: ionic charge, forbidden band, ZnS, electron, polaron, ionic polarization

ABSTRACT: The author undertook this study because of lack of any available reliable data on difference between optical width and thermal width of the forbidden band in the crystal lattice of ZnS affected by ionic polarization. He used two methods to arrive at this value. From the literature he obtained values to construct a graph showing dependence of absorption coefficient on energy of quanta, and by extrapolation to zero he obtained a value of  $3.9 \pm 0.2$  ev for the optical width of the forbidden band. From his own experimental work he plotted a graph for dependence of current on temperature, and from this obtained a value of  $3.2 \pm 0.2$  ev for the thermal width of the forbidden band. The difference by this technique thus proves to be  $0.7 \pm 0.4$  ev. Considering that the difference between thermal

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L 14295-63

ACCESSION NR. 001263

and optical energy values necessary to free electrons from traps has precisely the same character as the difference in thermal and optical widths of the forbidden band, he determined the difference in width to be  $0.55 \pm 0.15$  ev. He admits the latter derivation to be suspect, because the electrons (or holes) must be localized near the defects and must describe orbits of rather large radii around these defects else ionic polarization of the lattice will not occur. By computing frequencies of longitudinal and transverse optical phonons in the lattice of ZnS, the author determined values for effective ionic charge, the average value being  $0.5 \pm 1$  times the charge of an electron. The author concludes that the displacement of each ion of S during changes in the charge of a Zn ion, because of attachment of an electron to the Zn, gives birth to one longitudinal and one transverse phonon. But because the value of difference between optical and thermal width of the forbidden band is still known with too little precision, the conclusion is only tentative. "In conclusion I express my thanks to Ye. A. Konorova for her valuable comments." Orig. art. has: 2 figures and 15 formulas.

ASSOCIATION: none

SUBMITTED: 26Apr62

DATE ACQ: 01Jul63

SUB CODE: PH  
Card 2/2

NO REF SOV: 007

ENCL: 00

OTHER: 007

FOK, M.V.

Forbidden band with and effective charge in the crystal lattice of ZnS. Chekhosl fiz zhurnal 13 no.2:99-102 '63.

1. Physical Institute, Academy of Sciences of the U.S.S.R., Moscow.

L 13102-63

EWTC(1)/EOS AFFTC/ASD/SSD

ACCESSION NR: AP3003416

S/0051/63/015/001/0095/0099

AUTHOR: Georgobiani, A.N.; L'vova, Ye.Yu.; Fok, M.V.

TITLE: Temperature dependence of the electroluminescence yield

53

SOURCE: Optika i spektroskopiya, v.15, no.1, 1963, 95-99

TOPIC TAGS: electroluminescence, ZnS-Cu-Al phosphor

ABSTRACT: Earlier the authors (Optika i spektroskopiya, 13, 564, 1962 and Ibid., 9, 775, 1960) investigated the voltage dependence of the electroluminescence yield of ZnS:Cu:Al phosphor filled capacitors. In the present work, using the same experimental technique (described in the first reference) they investigated the temperature dependence and the voltage dependences at different temperatures of the electroluminescence of the same phosphors. The phonon mechanism is considered. Curves for the energy absorbed by the phosphor-filled capacitor as a function of the voltage for  $T = 114^{\circ}\text{K}$  and  $400^{\circ}\text{K}$  are given; as are plots of the electroluminescence yield versus voltage at 114, 294 and  $399^{\circ}\text{K}$ , and absorbed energy, electroluminescence brightness and yield as a function of the temperature (see Enclosure 1). The authors arrive at the following empirical formula for the brightness:

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ACCESSION NR: AP3003416

$$B(T) = B_0(T) e^{-\frac{b_1(T)}{\sqrt{V}}}$$

where T is the temperature, V is the voltage and  $b_1$  is a coefficient. The general conclusion is that the electroluminescent cell is a rather complicated electric system and that consequently a more precise model is necessary to obtain better agreement between theory and experiment. Orig.art.has: 8 formulas, 1 table and 4 figures.

ASSOCIATION: none

SUBMITTED: 26Jul62

DATE ACQ: 30Jul63

ENCL: 01

SUB CODE: PH

NO REF SOV: 006

OTHER: 000

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L 17783-63

ENP(q)/BDS AFFTC JD

ACCESSION NR: AP3005849

S/0051/63/015/002/0249/0252

AUTHOR: Voznesenskaya, T.I.; Fok, M.V.

54  
53

TITLE: Orange ZnS-Cu phosphor prepared by an electrolytic procedure

SOURCE: Optika i spektroskopiya, v.15, no.2, 1963, 249-252

TOPIC TAGS: phosphor synthesis, ZnS:Cu:Cl, zinc sulfide

ABSTRACT: The electrolytic technique for preparing phosphors has the advantage that it allows of introducing a single type of impurity ions, which is important for studying luminescence centers. The electrolytic technique was first employed by I.S.Andreyev, L.V.Zy\*rina and G.B.Arzuman'yan (Izv.AN Uzb.SSR, No.4,83,1961). The electrolytic procedure was used in the present study for preparing ZnS-Cu phosphors without Cl. It consisted of the following: luminescence pure ZnS, treated beforehand in hydrogen sulfide at 900°C to eliminat zinc sulfate, was loaded into a 6 mm diameter quartz tube between spectroscopic grade graphite electrodes (see the Enclosure); a 3 mm thick "plug" of previously prepared green-luminscing ZnS-Cu ( $10^{-4}$  g/g), Cl or a batch of flux-free ZnS-Cu ( $10^{-4}$  g/g) mix was packed in the center of the main charge (3 in Fig.1,a). The whole tube was then placed in a quartz

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L 17783-63

ACCESSION NR: AP3005849

test tube from which the air was displaced by dry and oxygen-free argon, and the whole assembly was heated in a furnace to 1060°C for 12-15 hours, while passing a current between the electrodes. The initial current was 2 mA, but this gradually increased to 8 mA. For control purposes a similar specimen was prepared without passage of current. The specimens prepared with passage of current luminesced. An orange band (2 mm or more wide, depending on the heating time) appeared near the cathode. The "plug" did not luminesce. The zinc sulfide at the anode luminesced blue, when the "plug" contained NaCl flux. The control specimen did not exhibit this behavior. The luminescence spectrum of the ZnS-Cu varied somewhat, depending on the electrolysis time. A number of variant experiments were performed. In addition to studying the luminescence centers formed by diffusion, the authors investigated the trap depths (the orange phosphor has few shallow traps). The effect of oxygen was also studied. The question of the chemical structure of the phosphors remains open, but the experimental results suggest that while formation of green centers is connected with the presence of lattice defects, the formation of orange centers is not. Orig. art. has: 3 figures and 1 table. 16

ASSOCIATION: none

SUBMITTED: 06Dec62

DATE ACQ: 06Sep63

ENCL: 01

SUB CODE: PH, CH

NO REF SOV: 002

OTHER: 003

Card 2/12

L 17780-63

EWI(1)/BDS AFFTC/ASD/ESD-3/IJP(C)/SSD

ACCESSION NR: AP3005852

S/0051/63/015/002/0266/0268

AUTHOR: Georgobiani, A.N.; L'vova, Ye.Yu.; Fok, M.V. 5.8

TITLE: Relation between the phases of the current, power absorbed and brightness in electroluminescence 1

SOURCE: Optika i spektroskopiya, v.15, no.2, 1963, 266-268

TOPIC TAGS: electroluminescence, brightness wave., luminescent capacitor

ABSTRACT: The authors investigated the same electroluminescent capacitors as earlier (A.N.Georgobiani and M.V.Fok, Opt. i spektro., 9, 775, 1960) using a circuit with and without a compensating capacitance. The luminescence was excited by a 50 cps sinusoidal voltage V at room temperature. A loop oscillograph was used to record the instantaneous values of V, the current I, the power W absorbed by the capacitor, and the brightness B of the emitted electroluminescence. A typical group of oscillograms is shown in the Enclosure. Analysis of the oscillograms recorded under different conditions (mainly changes in compensating capacitance altering the phase difference between the voltage and current) indicates that the relation between the phases or instants of the crest values of V, I, W and B can be explained

Card 1/3

L 17780-63

ACCESSION NR: AP3005852

satisfactorily with the aid of the concepts regarding the kinetics of electroluminescence proposed in earlier papers by the authors (above reference, A.N.Georgobiani and M.V.Fok. Optk i spektro.,11, 93, 1961, and A.N.Georgobiani, Ye.Yu.L'vova and M.V.Fok, Ibid.,13, 564, 1962): electrons are released primarily in the regions of maximum field, which are located in the immediate proximity of the electrodes; electroluminescence appears when these electrons arrive in the region of high concentration of ionized centers. In line with these concepts the brightness must attain its peak value before the current does, which is borne out by the experimental curves. Orig.art.has: 3 formulas and 3 figures.

ASSOCIATION: none

SUBMITTED: 19Jan63

DATEACQ: 06Sep63

ENCL: 01

SUB CODE: PH

NO REF SOV: 003

OTHER: 000

Card 2/3

L 12462-63

ENT(1)/ENT(2)/ENT(3)/ENT(4)/BDS AFFTC/ASD/IJP(C)/SSD JD

ACCESSION NR: AT3002232

S/2941/63/001/000/0263/0267

AUTHORS: Vinokurov, L. A.; Fok, M. V.

27B

TITLE: Dependence of luminescence brightness in ZnS-Cu, Co phosphors on Cu and Co concentration

SOURCE: Optika i spektroskopiya; sbornik statey, v. 1: Lyuminesentsiya. Moscow, Izd-vo AN SSSR, 1963, 263-267

TOPIC TAGS: luminescence, brightness, excitation, activator

ABSTRACT: A study has been made to determine the experimental verification of a theoretical prediction in which luminescence brightness is considered proportional to the excitation intensity. The luminescence brightness of several thin layers of luminophors with Cu concentrations of  $10^{-6}$  to  $10^{-5}$  gm/gm and Co concentration of  $0.3 \times 10^{-7}$  to  $10^{-5}$  gm/gm were measured in a region where the theoretical assumptions were considered valid. The ZnS samples contained NaCl melt and were  $40\mu$  thick. The test was carried at 140C. The average standard deviation of the measured brightness from the calculated values was less than 13%. Orig. art. has: 11 formulas, 1 figure, and 1 table.

Card 1/2

L 19482-63

ACCESSION NR: AT3002232

ASSOCIATION: none

SUBMITTED: 12Oct61

DATE ACQ: 19May63

ENCL: 00

SUB CODE: PH

NO REF SOV: 005

OTHER: 000

Card 2/2

L. 19485-63

EWI(1)/EWP(q)/EWI(m)/EWP(B)/BDS  
ACCESSION NR: AT3002236

AFPTC/ASD/IJP(C)/SSD JD  
S/2941/63/001/000/0285/0289

AUTHORS: Vinokurov, L. A. ; Fok, M. V.

TITLE: Initial stages of luminescence rise in ZnS-Cu, Co phosphors

SOURCE: Optika i spektroskopiya; sbornik statey. v. 1: Lyuminestsentsiya.  
Moscow, Izd-vo AN SSSR, 1963, 285-289

TOPIC TAGS: luminescence, inflection point, infrared, excitation

ABSTRACT: A study has been made to determine the causes leading to the disappearance of the inflection point on the luminescence rise curve of ZnS-Cu, Co under high intensity excitation. The effect of infrared excitation at energy levels of 0.35, 2.2, 210, and 770 ev on the S-shaped curve of luminescence growth was studied in detail. It is shown that at low excitation levels the inflection point disappears. But it is further emphasized at higher levels. A schematic of electronic transitions is proposed (see enclosure) and a necessary and sufficient condition for the existence of an inflection point is derived:

Card 1/02



L 19485-63

ACCESSION NR: AT3002236

$$\frac{d\beta}{\delta, w_1} < \frac{2}{3}$$

where  $\alpha$  is proportional to excitation intensity;  $w_1$  = probability of releasing holes; (see Enclosure 1 for remaining terms). The authors contend that the S-shape could be explained on the basis of the proposed band-schematic of one electronic and one p-type (hole) level. Orig. art. has: 11 formulas and 3 figures.

ASSOCIATION: none

SUBMITTED: 19Feb62

DATE ACQ: 19May63

ENCL: 01

SUB CODE: PH

NO REF SOV: 001

OTHER: 00C

Card 2/02

FOK, Mikhail Vladimirovich; DUBNOVA, V.Ya., red.

[Introduction to the kinetics of the luminescence of crystal  
phosphors] Vvedenie v kinetiku luminentsentsii kristallo-  
fosforov. Moskva, Izd-vo "Nauka," 1964. 283 p.

(MIRA 17:9)

ANTONOV-ROMANOVSKIY, V.V.; VINOKUROV, L.A.; FOK, M.V.

Anomalous storage of light sums in phosphors. Opt. i spektr. 16  
no.2:279-284 F '64. (MIRA 17:4)

ACCESSION NR: AP4020962

S/0051/64/016/003/0491/0495

AUTHOR: Bulcke, Ye.Ye.; Vinokurov, L.A.; Fok, M.V.

TITLE: Role of holes in the kinetics of electroluminescence of ZnS-Cu,Al,Cl phosphors

SOURCE: Optika i spektroskopiya, v.16, no.3, 1964, 491-495

TOPIC TAGS: electroluminescence, light sum storage, hole trap, zinc sulfide phosphor, hole migration, infrared stimulation, luminescence decay

ABSTRACT: It was demonstrated in an earlier investigation by one of the authors (M.V.Fok, Opt.i spektr.11,98,1961) that in the process of electroluminescence of phosphors the electric field releases, with high probability, holes from ionized luminescence centers located in high field concentration regions, and that the holes move towards the surface of the crystal. Accordingly, the present study was undertaken to determine whether holes that have emerged to the surface participate in the radiative recombination. The procedure was based on comparing the decay curves and the flare-up (stimulation) of emission by infrared after photo and electric excitation. The values of the electric field and exciting ultraviolet were selected so

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ACCESSION NR: AP4020962

that the mean brightness in the steady state would be the same. The chosen excitation wavelength was 365 mμ to insure uniform excitation throughout the volume of the crystal. The experiments were performed mainly with a ZnS:Cu:Al:Cl phosphor, which was capable of storing a large light sum and which was investigated earlier (V.V. Antonov-Romanovskiy, L.A. Vinokurov and M.V. Pok, Opt. i spektr. 16, 279, 1964). Some of the experimental data are presented in the form of curves. Analysis of the data indicates that under electric stimulation there forms a "reservoir" of holes, that is, that under the influence of the exciting electric field part of the holes emerge to the surface from the depth of the crystal, and then the holes migrate back into the volume of the crystal during the period of the afterglow. Also observed was an aging effect: the flare-up under infrared stimulation of a freshly prepared electroluminescent capacitor is weaker than that of a capacitor operated repeatedly for several hours; this is attributed to formation of additional hole traps. Orig.art.has: 4 figures.

ASSOCIATION: none

SUBMITTED: 12May63

DATE AC: 02Apr64

ENCL: 00

SUB CODE: PH

NR REF SOV: 002

OTHER: 000

Card 2/2

POK, M.V.

Concerning the discussion on the quenching of the luminescence  
of solutions. Opt. i spektr. 17 no.5:804 N '64.

(MIRA 17:12)

L 29664-65 BW1(1) IJP(c)

ACCESSION NR: AP5001291

P/CONF 164/CONF 164/521/529

AUTHOR: Antonov-Romanovsky, V.V.; Vinokurov, L. A.; Fok, M. V.

TITLE: Luminescence<sup>2</sup> of inorganic materials: the role of the stimulating action of the exciting light in phosphorescence phenomena

SOURCE: Acta physica polonica, v. 26, no. 3-4, 1964, 521-529

TOPIC TAGS: luminescence, luminescence phenomenon, crystalline phosphor, exciting light, light sum accumulation

ABSTRACT: This paper presents data on exciting light and its stimulating action in phosphorescence phenomena in crystalline phosphors. The stimulating action of exciting light is used to explain 1) the limitation of light sum accumulation at a limited increase in excitation intensity, 2) the dependence of the accumulated light sum limit on the wavelength of exciting light, 3) the decrease of electron accumulation in deep traps with cooling or with increasing excitation, and 4) the decrease of luminous efficiency with increase in excitation intensity. The intersection of decay curves of some phosphors at different excitation intensities can also be explained by the stimulating action of the light.

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L 22664-65

ACCESSION NR: AP5001291

The intersection indicates that in later stages of decay the light sum accumulation in phosphors following weaker excitation is larger than after stronger excitation. The experimental data on light sum accumulation in a single phosphor are given. The explanation is accomplished with the aid of a phosphor model containing two electron traps and one kind of light center. Orig. article contains formulas and figures.

ORIGINATOR: P.N. Lebedev Physical Institute of the Academy of Sciences of the USSR

SUBMITTED: 00

ENCL: 00

SUB CODE: OP,SS

RECEIVED: 009

OTHER: 001



VREDEN-KOBETSKAYA, T.O.; GEORGOBIANI, A.N.; GOLUBEVA, N.P.;  
GRIGOR'YEV, N.N.; ZHEVANDROV, N.D.; MORGENSHTERN, Z.L.;  
PETUKHOVA, M.S.; RABINOVICH, N.Ya.; FOK, M.V.;  
KHAN-MAGOMETOVA, Sh.D.; ANTONOV-ROMANOVSKIY, V.V., doktor  
fiz.-mat. nauk, otv. red.

[Luminescence; a bibliographic index for 1947-1961] Liu-  
minestsentsiia; bibliograficheskii ukazatel', 1947-1961.  
Moskva, Nauka. Vol.2. 1964. 378 p. (MIRA 18:4)

1. Akademiya nauk SSSR. Sektor seti spetsial'nykh bibliotek.

ACCESSION NR: AP5011120

UR/0051/65/018/004/0656/0660  
576.547.1

AUTHOR: Voznesenskaya, T. I.; Fok, M. V.

TITLE: On the nature of red luminescence in ZnS-Cu phosphors

SOURCE: Optika i spektroskopiya, v. 18, no. 4, 1965, 656-660

TOPIC TAGS: zinc sulfide optical material, luminescence, acceptor level, donor level, luminescence center

ABSTRACT: This is a continuation of earlier work (Opt. i spektr. v. 15, 249, 1963) on orange-glow ZnS-Cu phosphors, in which the red luminescence centers were attributed to donor action of Cu. To check on this assumption, the authors investigated in the present research the temperature dependence of the conductivity of orange-glow phosphors and also the green-glow phosphors (where the copper forms an acceptor level in ZnS). The measurements were carried out on ZnS-Cu phosphors and on ZnS-Cu phosphors with a small amount of Cu. The temperature dependence of the orange phosphor offers evidence of ionic conductivity. To check whether the conductivity is produced by holes or

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10-107-65

ACCESSION NR: AP5011120

by electrons, the authors compared the kinetics of the red luminescence, on one hand, and that of blue and green luminescence on the other. The results indicate that the red luminescence occurs only in the presence of free holes that can recombine with electrons at 1.6 eV donor levels, thus offer us evidence in favor of the presence of the copper. Orig. art. has: 4 figures

ASSOCIATION: None

ENCLOSURE

FILE COPY

L 00981-66 EWT(1' IJP(c)  
ACCESSION NR: AP5016175

UR/0051/65/018/006/1024/1030  
535.376

AUTHOR: Fok, M. V.

TITLE: Energy yield and mechanism of electroluminescence 21

SOURCE: Optika i spektroskopiya, v. 18, no. 6, 1965, 1024-1030

TOPIC TAGS: electroluminescence, recombination luminescence, radiative recombination, semiconductor band structure, impact ionization, tunnel effect

ABSTRACT: Three possible mechanisms for excitation of electroluminescence are considered: 1) impact ionization (or impulse excitation), where the electrons (or holes) which are accelerated in a strong field acquire sufficient energy for ionization (excitation) of luminescence centers or for ionization of the basic lattice (i.e., for transfer of electrons from the valence band to the conduction band; 2) the tunnel effect (Zener effect), where electric field-induced electron emission takes place from the luminescence center levels or from the valence band to the conduction band; 3) injection of minority charge carriers through a p-n junction connected in

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L 00981-66

ACCESSION NR: AP5016175

the forward direction, where the electrons in the n-region and the holes in the p-region travel toward each other and give off radiation as they recombine after meeting in the junction region. Only the third mechanism gives a high electroluminescence energy yield. The greatest efficiency in this case is reached when the applied potential difference in volts is equal to the width of the forbidden zone in the semiconductor in electron volts. The reason for this is that each electron-hole recombination precedes transference of a charge equal to that of the electron throughout the entire impressed difference in potentials. As the voltage is increased past this optimum point, the brightness of the luminescence increases while efficiency decreases; since the energy of the emitted quanta depends only slightly on the applied potential difference. For this reason, the area of the luminous surface must be increased instead of the brightness in order to increase the luminous flux. The most efficient devices for this purpose would be electroluminescent capacitors made up of a thin sublimated layer of an electrophosphor coated on both sides with dielectric films a few molecules thick, i.e. of the order of 10 Å, placed between a metal electrode and a conducting glass plate and operating at an a-c or d-c potential of the order of a few volts. The phosphor should have a base with an absorption edge on the border between the visible and ultraviolet regions; i.e., the width of the forbidden zone should be about 3 ev, since a wider forbidden zone

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L 00981-66

ACCESSION NR: AP5016175

causes an unnecessary increase in the energy used for creating free electrons and holes, and radiation in the blue portion of the spectrum would be impossible with a narrower forbidden zone. Orig. art. has: 2 figures. [14]

ASSOCIATION: none

SUBMITTED: 04May64

ENCL: 00

SUB CODE: OP, SS

NO REF SOV: 000

OTHER: 002

ATD PRESS: 4069

Card 3/3

... 2.2, M.V.

... of current by an electric field ...

... of the ...

... luminescence, rectifier, and ...

... have investigated the ...

... in which the dielectric was ...

... of the ...

... a function of ...

... given by

$$I = A e^{-\frac{1}{V_0}}$$

The electroluminescence intensity was given by a similar formula but with a smaller value of the constant  $\beta$ . No rectification occurred in the absence of ZnS,

... of photoluminescent but not electroluminescent ... recti-

... independent of the nature of the electrodes and fast ... to

Card 1/3

L 49241-65

ACCESSION NR: AP5010816

a ... of the dielectric suspension arising during its deposition. This ...  
 described to orientation of the irregular ...  
 points ...

Schottky barriers between the ZnS grains and the metallic-conducting phase, and  
 this effect is discussed briefly. The frequency dependence of the rectified cur-  
 rent was reproduced by an equivalent circuit consisting of a constant resistance

a constant capacitance shunted by a ... resistance

... formulas, 7 figures, and 1 table.

... Fizicheskii institut im. P.N. Lebedev ...

Card 2/3



1. 4475125 EWT(1)/EPA(s)-2/EWT(m)/EFF(c)/EXP(j)/ENAL(f) Po-1, Pr-4 Pt-7 P-4  
 2. 4475125 EWT(1)/EPA(s)-2/EWT(m)/EFF(c)/EXP(j)/ENAL(f) Po-1, Pr-4 Pt-7 P-4  
 3. 4475125 EWT(1)/EPA(s)-2/EWT(m)/EFF(c)/EXP(j)/ENAL(f) Po-1, Pr-4 Pt-7 P-4

AUTHOR: Fok, M.V.; Chukova, Yu.P.

TITLE: Temperature dependence of the rectified current of an electroluminescent capacitor

SOURCE: Zhurnal tekhnicheskoy fiziki, v.35, no.6, 1965, 1139-1144

1. electroluminescence, tunnel effect, electron-electron interaction, rectification, zinc sulfide

2. The rectified current in an electroluminescent capacitor

3. The rectified current in an electroluminescent capacitor

4. The rectified current in an electroluminescent capacitor

5. The rectified current in an electroluminescent capacitor

6. The rectified current in an electroluminescent capacitor

7. The rectified current in an electroluminescent capacitor

8. The rectified current in an electroluminescent capacitor

9. The rectified current in an electroluminescent capacitor

10. The rectified current in an electroluminescent capacitor

Card 1/3

1 54751-46

ACCESSION NR: AP5015640

theory of L.V.Kledysh (ZhETF 34,962,1958) concerning the role of photons in the production of electron-hole pairs by a strong electric field. In the investigated temperature range which was limited by the static properties of the polyacetylene, the theory of L.V.Kledysh is in agreement with the data of A. Leyfield and E.Guereigh (C.R., 257, No.4, 852, 1963) on the magnetic field effect on electroluminescence, but it contradicts the estimates of G.I. Gulyaev (Izv. Akad. Nauk SSSR, 1958) and A.B. L'vov (Izv. Akad. Nauk SSSR, 1958). By assuming that the electric field in the barrier region is of the order of  $10^6$  V/cm, it was calculated that the thickness of a barrier is  $10^{-5}$  cm and the concentration of the ionization centers producing it is of the order of  $10^{17}$  cm $^{-3}$ . The authors express their gratitude to L.V.Kledysh for a number of valuable remarks and discussion of the results." (Izv. Akad. Nauk SSSR, 1958, 1959, 1960, 1961, 1962, 1963, 1964, 1965, 1966, 1967, 1968, 1969, 1970, 1971, 1972, 1973, 1974, 1975, 1976, 1977, 1978, 1979, 1980, 1981, 1982, 1983, 1984, 1985, 1986, 1987, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025)

This value of the electric field is in agreement with the data of A. Leyfield and E.Guereigh (C.R., 257, No.4, 852, 1963) on the magnetic field effect on electroluminescence, but it contradicts the estimates of G.I. Gulyaev (Izv. Akad. Nauk SSSR, 1958) and A.B. L'vov (Izv. Akad. Nauk SSSR, 1958). By assuming that the electric field in the barrier region is of the order of  $10^6$  V/cm, it was calculated that the thickness of a barrier is  $10^{-5}$  cm and the concentration of the ionization centers producing it is of the order of  $10^{17}$  cm $^{-3}$ . The authors express their gratitude to L.V.Kledysh for a number of valuable remarks and discussion of the results." (Izv. Akad. Nauk SSSR, 1958, 1959, 1960, 1961, 1962, 1963, 1964, 1965, 1966, 1967, 1968, 1969, 1970, 1971, 1972, 1973, 1974, 1975, 1976, 1977, 1978, 1979, 1980, 1981, 1982, 1983, 1984, 1985, 1986, 1987, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025)

Card 2/3

NR: AP6015640

ORIGIN: Fizicheskii Institut imeni P.N. Lebedeva AN SSSR, Moscow  
(Institute, AN SSSR)

SUBMITTED: 14Apr64

ENCL: 00

SUB CODE: FC, OP

NR REF SOV: 005

OTHER: 007

Card 3/3

L 10670-66 EWT(1) IJP(c) AT

ACC NR: AP5028322

SOURCE CODE: UR/0057/65/035/011/2065/2068

AUTHOR: <sup>44, 55</sup> <sup>44, 55</sup> Fok, M.V.; Chukova, Yu. P.ORG: <sup>44, 55</sup> Physics Institute im. P.N. Lebedev, Moscow (Fizicheskii institut im. P.N. Lebedeva)TITLE: Frequency dependence of the current rectified by an <sup>21, 44, 55</sup> electroluminescent capacitor

SOURCE: Zhurnal tekhnicheskoy fiziki, v. 35, no. 11, 1965, 2065-2068

TOPIC TAGS: electroluminescence, semiconductor rectifier, frequency characteristic, tunnel effect, *electric current, capacitor*

ABSTRACT: The authors have continued their earlier investigations of the current rectified by electroluminescent capacitors (ZhTF 35, 762, 1139, 1965). The rectified current  $I$  was previously found to be given in terms of the applied voltage  $U$  and the frequency  $f$  by the equation  $I = C \exp(-\beta/U^{1/2})/(R_c/f^p)$ , where  $C$ ,  $\beta$ , and  $p$  are constants. The factor  $R_c/f^p$  has previously been identified with the resistance of the barriers in the heterogeneous layer. Measurements at a number of different audio frequencies and at potential voltages from 25 to 160 V have now revealed a frequency dependence of the parameters. The measurements can be represented, except at the highest voltages, by replacing  $\beta$  in the above equation with  $\beta_0 + k \log f$ , or by replacing  $p$  with  $p_0 - k/U^{1/2}$ , where  $\beta_0$ ,  $k$ , and  $p_0$  are constants. The significance

Card 1/2

UDC:535.376

L 10670-66

ACC NR: AP5028322

3  
of these results is discussed briefly. This discussion involves a relation (not given) between the field intensity within the barrier and the temperature  $T_0$  below which the number of pairs produced by tunneling is not temperature dependent, derived by L.V.Keldysh (ZhETF, 34, 962, 1958), and previous measurements at 50 Hz of  $T_0$  by the authors (loc.cit.supra). It is concluded that different fields are responsible for current rectification and for electroluminescence, and that the field responsible for current rectification is the smaller of the two and is the only one of them that is frequency dependent. This difference may be associated with the fact that a potential drop of 0.4 eV/sic/ is required for transmission of current, whereas about 3 eV are required for ionization of the luminescence centers. The authors thank O.A.Toropova for assisting with the measurements. Orig. art. has: 8 formulas and 3 figures. 4155

SUB CODE: 09

SUBM DATE: 03Mar65/

ORIG. REF: 005 OTH REF: 000

Card 2/2

ACC NR: AF6033437

SOURCE CODE: UR/0051/66/021/004/0449/0455

AUTHOR: Bukke, Ye. Ye.; Vinokurov, L. A.; Fok, M. V.

ORG: none

TITLE: Band scheme describing the kinetics of photoluminescence of SiC

SOURCE: Optika i spektroskopiya, v. 21, no. 4, 1966, 449-455

TOPIC TAGS: photoluminescence, silicon carbide, exciton absorption, recombination luminescence, radiative recombination, light excitation, temperature dependence, semiconductor band structure

ABSTRACT: The purpose of the investigation was to ascertain the degree to which SiC doped with nitrogen is governed by the exciton mechanism and what the contribution of the recombination luminescence is, and if the luminescence has a recombination character, to identify the centers in which the radiative recombination takes place. ... Several crystals of n-type SiC were investigated, containing nitrogen and unknown acceptor impurities. When excited with 3.4-ev quanta (365 nm), these crystals had weak orange luminescence at room temperature, which became stronger at 77K, when an additional blue band appeared. The effect of excitation with infrared light ( $h\nu = 1$  ev), and the dependence of the brightness on the temperature and on the nitrogen concentration were also investigated. The observed small luminescence yield and most of the observed phenomena can be explained if it is assumed that the recombination is by two different centers, both of which are acceptors but have different chemical nature.

Card 1/2

UDC: 535.37: 548.0

ACC NR: AF6033437

The fraction of the exciton luminescence in the blue band is estimated at 10 - 50%, and it is concluded that there is no excited luminescence in the orange band. The data do not exclude the possibility that all of the luminescence is produced by the recombination mechanism. There is no evidence in favor of assuming that the recombination centers are donors, and that nonradiative recombination of free holes with electrons occurs. The authors thank M. B. Reyman for supplying the crystals. / Orig. art. has: 4 figures and 1 formula.

SUB CODE: 20/ SUBM DATE: 06Apr65/ ORIG REF: 002/ OTH REF: 002

Card 2/2

L 26488-66 EWT(1)/EWA(h)

ACC NR: AP6013067

SOURCE CODE: UR/0048/66/030/C04/0620/0627

AUTHOR: Kylasov, V.A.; Lyamichev, I.Ya.; Orlov, I.N.; Perishin, G.G.; Peterimov, S.V.; Taborko, N.I.; Fok, M.V. 77  
E

ORG: None

TITLE: Problems involved in the development of electroluminescent indicators and image converters / Report, Fourteenth Conference on Luminescence held in Riga, 16-23 September 1965/ 25

SOURCE: AN SSSR. Izvestiya. Seriya fizicheskaya, v. 30, no. 4, 1966, 620-627

TOPIC TAGS: real time data display, image converter, electroluminescence, phosphor, information storage and retrieval, control circuit

ABSTRACT: The paper is devoted to a general discussion of the problems involved in development of electroluminescent display screens (matrix screens) and electroluminescent converters of visible and x-ray images. In conjunction with the screens it is indicated that current research is aimed at increasing the peak brightness of electroluminescent phosphors (important because the average viewing brightness is a function of the maximum brightness multiplied by the excitation time of a screen element and divided by the interval between successive activations) and development of means for realization of information storage on or for the screen. Approaches to enhancement of brightness are improvement of the composition of phosphors and electroforming, which involves application of an ac or dc potential to the electroluminescent 2.

Cord 1/2



L 26488-66

ACC NR: AP6013067

capacitor while the binder (paraffin) is solidifying. Realization of storage is connected with development of appropriate control circuitry, including external storage components. A block diagram of a control circuit for a matrix screen with external storage is shown in a figure. Research in the field of image converters is being carried out along the lines of improving the parameters of photoconducting powdered materials in the visible and x-ray regions, theoretical and experimental determination of the optimum operating conditions for converters of different design, design development and improvement of the technology of image converters. A table gives a series of formulas that should be useful in designing new image converters. Mention is made of work on development of tubes for converting ultrasonic images to visible images. Photographs reproduced in the text show a converter image of a TV test pattern and images of x-ray pictures of some vacuum tubes and electronic components displayed on a 200 cm<sup>2</sup> screen. Orig. art. has: 14 formulas and 5 figures.

SUB CODE: 09, 20/

SUBM DATE: 00/

ORIG REF: 005/

OTH REF: 004

Card 2/2 f/

ACC NR: AP/000029

SOURCE CODE: UR/0051/66/021/005/0588/0591

AUTHOR: Vinokurov, L. A.; Fok, M. V.

ORG: none

TITLE: Effect of infrared light on the photoluminescence of SiC-N

SOURCE: Optika i spektroskopiya, v. 21, no. 5, 1966, 588-591

TOPIC TAGS: silicon carbide, ir absorption, photoluminescence, luminescence spectrum, impurity level, polaron

ABSTRACT: This is a continuation of earlier work (Opt. i spektr. v. 21, 449, 1966) where a band scheme was proposed to describe the photoluminescence of SiC crystals doped with nitrogen. The authors state that if the scheme proposed in the earlier paper is valid, then when the sample is exposed to infrared, there should be observed, during the afterglow time, a flash whose spectrum contains the two blue bands observed in ordinary light. Experiments have indeed shown that the application of infrared light eliminates the structure in the spectrum of the blue band. To check the extent to which the sensitivity of the investigated crystals to infrared extends toward longer wavelengths, the authors measured the intensity of the flash as a function of the quantum energies of the infrared light incident on the same crystal whose luminescence spectrum was investigated earlier. The results show that the sensitivity to infrared has a complicated structure, with a maximum in the vicinity of 0.34 ev. Curves corresponding to turning on the infrared light 7 and 30 seconds

Card 1/2

UDC: 535.37

ACC NR: AP7000029

after the cessation of the excitation are practically parallel, but the 30-second curve drops off more rapidly and has a smaller peak. Dips observed at 0.34 and 0.28 eV correspond to acceptor levels due to boron and aluminum. This agrees with earlier calculations of the depths of the impurity levels. Comparison with ZnS shows that the polaron energy in SiC is much lower than ZnS. The authors thank Ye. Ye. Bukka for help with the work. Orig. art. has: 4 figures.

SUB CODE: 20/ SUBM DATE: 16Jun65/ ORIG REF: 002

Card 2/2

FOK, M.

"Band gap and effective charge of ions in the ZnS lattice."

Report submitted to the Symp. on Luminescence, Prague, Czech. 24-28 Sep 1962.

4

13

**Mechanism of the mercury-catalysed photochemical oxidation of propane.** N. V. Fok, B. B. Bereslavski, A. M. Nalbandyan, and V. Ya. Shtern. *Doklady Akad. Nauk S.S.S.R.* 27, 490-501(1949).-- in equimol. mixts. of  $C_3H_8 + O_2$  under 80 mm., at room temp., the amt. of peroxides becomes const. after ~ 30 sec. and attains ~ 1% of the  $C_3H_8$  passed; at 100°, the amt. of peroxides const. after ~ 100 sec., reaches about 4%; aldehydes, absent at room temp., attain approx. 1.5%. The ratio is reversed at 300°, with peroxides falling to 1.75%, and the amt. of aldehydes attaining 6%. The amts. of peroxides, plotted as a function of the temp. at a given moment (100 sec.), pass through a max. at about 150°, whereas the amt. of aldehydes increases linearly with the temp. Evidently, the primary process is the formation of peroxides. N. Thom

Inst. Phys. Chem., AS USSR

FOK, N. V.

"Photochemically Sensitized Oxidation of Propane Using Mercury."  
Sub 4 Jan 52, Inst of Chemical Physics, Acad Sci USSR.

Dissertations presented for science and engineering degrees in  
Moscow during 1951.

SO: Sum. No. 480, 9 May 55

*CAND. CHEMICAL Sci.*

FOK, N. V.

239T27

USSR/Chemistry - Fuels  
Reaction Kinetics

Aug 52

"Investigation of the Composition of Peroxides Formed  
in the Oxidation of Propane at Room Temperature With  
Photochemically Sensitized Mercury," N. V. Fok and  
A. B. Nalbandyan

"DAN SSSR" Vol 85, No 5, pp 1093-1095

On the basis of chem and polarographic analysis and  
through the reaction of the peroxide with various  
substances, it was established that the peroxide  
formed during the oxidation of propane with photo-  
chemically sensitized Hg at room temp is isopropyl  
hydrogen peroxide. Submitted by Acad N. N. Semenov  
23 May 52.

239T27

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USSR/Chemistry - Fuels, Peroxides

21 Sep 52

"The Mechanism of the Reaction of the Oxidation of Propane With Photochemically Sensitized Mercury at Room Temperature," N. V. Fok and A. B. Nalbandyan

DAN SSSR, Vol 86, No 3, pp 589-592

Propane is oxidized at room temp with photochemically sensitized Hg to form propyl hydrogen peroxide. The reaction proceeds with a preliminary excitation of the propane mol. Presented by Acad. N. N. Semenov 5 Jun 52

247T17



Fok, N. V.

✓ The photochemical oxidation of propane at high temperatures. N. V. Fok and A. B. Nalbandyan. *Doklady Akad. Nauk S.S.S.R.* 89, 125-7 (1953).—The photochem. oxidation of  $C_3H_8$  was carried at 100–300°, for equal mixts. of  $C_3H_8$  and O at a pressure of 50 mm. At 100° AcH is present in the reaction products. At 200°, along with isopropyl hydroperoxide and AcH, formaldehyde is present in the reaction products to almost the same extent as AcH. As the temp. is further increased, the ratio of formaldehyde to AcH increases. Among the oxidation products at 300° are acetone and CO. The exptl. results indicate that the active centers for the photochem. reaction are the peroxide radicals which perish on the walls of the reaction vessel.

J. Rovtar Leach

①

SKURATOV, S.M.; VOYEVODSKIY, V.V.; STREPIKHAYEV, A.A.; KANARSKAYA, Ye.H.;  
MUROMOVA, R.S.; FOK, N.V.

Kinetics and thermal effect of the polymerization of enantholactam.  
Dokl.AN SSSR 95 no.3:591-594 Mr '54. (MLRA 7:3)

1. Moskovskiy gosudarstvennyy universitet im. M.V.Lomonosova.
2. Institut khimicheskoy fiziki Akademii nauk SSSR. Predstavleno akademikom V.N.Kondrat'yevym.  
(Polymers and polymerization) (Enantholactam)

*Fok N.V.*

USSR/Kinetics - Combustion. Explosions. Topochemistry. Catalysis. B-9

Abs Jour : Referat Zhur - Khimiya, No 6, 1957, 18562

Author : N.V. Fok, A.B. Nalbandyan.

Inst : Academy of Sciences of USSR.

Title : To Mechanism of Photochemical Oxidation of Hydrocarbons.

Orig Pub : in the symposium Tsepnyye reaktsii okisleniya uglevodorodov v gazovoy fatsii. M., AN SSSR, 1955, 118-139.

Abstract : Review of works published by the authors earlier (Nalbandyan A.B., Zh. fiz. khimii, 1948, 22, 1443; Dokl. AN SSSR, 1949, 66, 473; Fok N.V., Bereslavskiy B.B., Nalbandyan A.B., Shtern V.Ya., Dokl. AN SSSR, 1949, 67, 499; Fok N.V., Nalbandyan A.B., Dokl. AN SSSR, 1952, 85, 1093; 86, 589; RZhKhim, 1953, 2853).

Card 1/1

- 233 -

AUTHORS: Ivanov, O. A., Fok, N. V., Voyevodskiy, V. V. 20-118-6-26/43

TITLE: Reaction Between Methyl Radicals Obtained According to the Method of Polanyi and Deuterium (Reaktsiya metil'nykh radikalov, poluchennykh po metodu Polyani, s deyteriyem)

PERIODICAL: Doklady Akademii Nauk SSSR, 1958, Vol. 118, Nr 6, pp. 1142-1145 (USSR)

ABSTRACT: First previous papers dealing with the same subject are shortly referred to. The authors produced the methyl radicals according to the method of Polanyi (Polyani) according to the reaction  $\text{CH}_3\text{J} + \text{Na} = \text{CH}_3 + \text{NaJ}$ . The reaction passed in presence of molecular deuterium which was used as carrier gas for sodium vapors. The scheme of the experimental arrangement is illustrated in a figure. The reaction container in which the jets of  $\text{CH}_3\text{J}$  combine with those of deuterium consisted of a quartz cylinder with a nozzle. In one series of experiments the inner surface of the reaction container was covered with sodium which was applied in form of drops or as reflecting

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20-118-6-26/43

Reaction Between Methyl Radicals Obtained According to the Method  
of Polyani and Deuterium

coating. The deuterium used for the experiments was produced electrolytically from  $D_2O$ . The authors detected the composition of the methanes obtained in a pure quartz container in the temperature interval of from 20-480°C. Under these conditions mainly  $CH_4$  and  $CH_3D$  are obtained. The quantity of the semi-deuterized methanes is small and reaches the value 18-20% only in a small temperature interval near 200°C. The ratio  $CH_3D/CH_4$  increases in the interval of from 20-100°C from 0,6 to 2, and remains constant in the case of further temperature rise. The deuterium content in the investigated methanes is considerably changed in the case of a deposit of metallic sodium on the surface of the container. Here the connection between the portion of the different deuterized methanes and the temperature depends on the kind of applying of sodium to the surface. In covering the container surface with a reflecting sodium the percentage of to a great extent deuterized methanes ( $CD_4$ ,  $CD_3H$

Card 2/4

20-118-6-26/43

Reaction Between Methyl Radicals Obtained According to the Method  
of Polyani and Deuterium

and  $CD_2H_2$ ) is at room temperature by 5 to 8 times greater than in a pure quartz container. In the case of a temperature rise the percentage of the to a great extent deuterized methanes decreases. In the case of sodium drops the surface reaction is insignificant and its portion of the volume of the methane produced amounts to totally only 1/5. Here the methanes obtained from the radicals  $CH_3$  contain much more deuterium than in the case of a reflecting coating sodium. The maximum of the deuterization at 70-80°C is striking. At higher temperatures  $CH_4$  and  $CH_3D$  predominate again. In the case of sodium drops the light methane is not exchanged with  $D_2$  as it is the case in the case of existence of a reflecting coating. This exchange has to take place with participation of the methyl radicals independently of the kind of mechanism of the production of  $CH_2D_2$ ,  $CH_3D$  and  $CD_4$ .

Card 3/4

20-118-6-26/117

Reaction Between Methyl Radicals Obtained According to the Method  
of Polyani and Deuterium

There are 3 figures and 8 references, 3 of which are Soviet.

ASSOCIATION: Kafedra khimicheskoy kinetiki Moskovskogo gosudarstvennogo  
universiteta im. M. V. Lomonosova  
(Chair of Chemical Kinetics, Moscow State University  
imeni M. V. Lomonosov )  
Institut khimicheskoy fiziki Akademii nauk SSSR  
(Institute of Chemical Physics, AS USSR)

PRESENTED: July 26, 1957, by N. N. Semenov, Member, Academy of Sciences  
of USSR

SUBMITTED: July 19, 1957

Card 4/4

83566

S/020/60/134/001/019/021  
B004/B060

5.4500

AUTHORS: Shelimov, B. N., Bubnov, N. N., Fok, N. V.,  
Voyevodskiy, V. V., Corresponding Member AS USSR

TITLE: Detection of Hydrogen Atoms in the Phototransfer Reactions  
of the Electron 2/

PERIODICAL: Doklady Akademii nauk SSSR, 1960, Vol. 134, No. 1,  
pp. 145 - 148

TEXT: The authors proceed from the photochemical reaction in the aqueous medium:  $M + H_2O + h\nu \rightarrow M^+ + OH^- + H(1)$ , where M may be metal ions of variable valency, or anions. The formation of hydrogen atoms in this reaction had been hitherto proved indirectly only. The authors wanted to give direct evidence of H-atoms by means of electric paramagnetic resonance (epr). Because of the strong reactivity and mobility of the H-atoms, investigations were conducted at 77°K in aqueous solutions of  $H_2SO_4$  or  $H_3PO_4$  (in concentrations between 40 and 96%), which contained small quantities of  $FeSO_4$  or KI. The samples were irradiated for 1 hour

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Detection of Hydrogen Atoms in the  
Phototransfer Reactions of the Electron

S/020/60/134/001/019/021  
B004/B060

with the ultraviolet light of a ПРК-7 (PRK-7) mercury vapor lamp. The epr signals were recorded by means of a previously described (Ref. 7) epr spectrometer. It was possible to give evidence of the H-doublet. To check the correctness of reaction (1) definitely, experiments were made in solutions which contained heavy water. As is shown by Fig. 1, the D-triplet was observed besides the H-doublet. Further experiments were conducted in the system  $C_6H_6 - H_2O - H_2SO_4$ . Here as well (Fig. 2) the H-doublet occurred. The central part of this spectrum, the quadruplet shown in Fig. 3, could not be explained yet, but it might be due to a paramagnetic particle whose free valency is localized on the aromatic ring. Weaker components were detected in the epr spectrum of the H-atom (Fig. 4), which are ascribed to the spin reversal of protons surrounding the H-atom. While the H-lines were strongly saturated in the experiments with benzene, saturation did not take place in the presence of  $Fe^{2+}$  due to higher concentration of the paramagnetic ions of a short relaxation time. The study of saturation and intensity distribution between the main and secondary lines in the epr spectrum of  $H^\bullet$  may serve to clarify specific features of its weak interaction

Card 2/3

83566

Detection of Hydrogen Atoms in the  
Phototransfer Reactions of the Electron

S/020/60/134/001/019/021  
B004/B060

with adjacent molecules, and also to establish the distance between H<sup>•</sup>-atoms and primary particles releasing an electron under the action of light. There are 4 figures and 12 references: 3 Soviet, 8 US, and 2 British.

ASSOCIATION: Moskovskiy gosudarstvennyy universitet im. M.V. Lomonosova  
(Moscow State University imeni M.V. Lomonosov). Institut  
khimicheskoy kinetiki i goreniya Sibirskogo otdeleniya  
Akademii nauk SSSR (Institute of Chemical Kinetics and  
Combustion of the Siberian Branch of the Academy of  
Sciences, USSR)

SUBMITTED: April 27, 1960

Card 3/3

BUBNOV, N.N.; VOYEVODSKIY, V.V.; FOK, N.V.; SHELIMOV, B.N.

Study of electron phototransfer reactions in the solid phase  
by the electron paramagnetic resonance method. Opt.1 spektr.  
11 no.1:78-83 J1 '61. (MIRA 14:10)  
(Paramagnetic resonance and relaxation)  
(Photomuclear reactions)

29010

S/020/61/140/004/011/023

B106/B110

11.1510

AUTHORS: Varbanskaya, R. A., Shelimov, B. N., and Fok, N. V.

TITLE: Reactions of "hot" methyl radicals in solid phase at low temperatures

PERIODICAL: Akademiya nauk SSSR. Doklady, v. 140, no. 4, 1961, 818-821

TEXT: The authors studied the conditions of stabilization and the conversions of methyl radicals obtained by photolysis of methyl iodide, azomethane, acetone, and acetaldehyde at 77°K. The role of "hot" radicals, i.e., methyl radicals with excess energy, in these processes was clarified. The analysis of gaseous reaction products and data of electron paramagnetic resonance (epr) spectra were used for this study. Transparent solid solutions of the tested compounds in methyl cyclohexane were photolyzed in a quartz vessel cooled by liquid nitrogen. The concentration of solutions was 0.02-0.15 moles/liter, and a ПРК-7 (PRK-7) mercury lamp was used as irradiation source. The epr spectra were recorded on an ЭПР-2 (EPR-2) device (Ref. 9: A. G. Semenov, N. N. Bubnov, Priory i tekhn. eksperim. (Devices and technical experiments), No. 1, 92 (1959)).

Card 1/43

29010

S/020/61/140/003/011/023  
B106/B110

Reactions of "hot" methyl ...

A EC-5 (BS-5) filter pervious to light of  $\lambda > 3100 \text{ \AA}$ , and a filter filled with a mixture of  $\text{Cl}_2$  and  $\text{Br}_2$  and pervious to light of  $\lambda < 2900 \text{ \AA}$  were used

in some of the experiments. In the photolysis of azomethane in solid phase, one molecule of nitrogen and ethane each were formed per decomposing molecule of azomethane, and, additionally, methane in a ratio of  $\text{CH}_4/\text{C}_2\text{H}_6 \sim 0.04$  independent of the intensity of light. Methane was the

only gaseous reaction product in the photolysis of methyl iodide. Acetone was not decomposed under the conditions applied, acetaldehyde slightly decomposed to about equal quantities of CO and  $\text{CH}_4$ . The fact

that the ratio  $\text{CH}_4/\text{C}_2\text{H}_6$  found for azomethane decomposition was

independent of the intensity of light indicates that ethane is formed by recombination of methyl radicals in the interior of a "cell", and not by recombination of free radicals. The formation of methane in the photolysis of methyl iodide and azomethane at low experimental temperature ( $77^\circ\text{K}$ ) suggests the formation of "hot" methyl radicals in the solid phase. The stability of acetone to photolysis indicates the absence of "hot" radicals. The reason is the large difference between the bond energies of the C-C bond in acetone (77 kcal/mole) and of the C-I bond in methyl

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29010

S/020/61/140/004/011/023

B106/B11C

Reactions of "hot" methyl ...

iodide (54 kcal/mole). The participation of "hot" methyl radicals in the formation reaction of methane was confirmed by photolysis of azomethane in light of different wavelengths. Increasing light energy ( $\lambda < 2800 \text{ \AA} \rightarrow \lambda > 3100 \text{ \AA}$ ) causes the increase of the ratio  $\text{CH}_4/\text{C}_2\text{H}_6$  ( $1 \rightarrow 7$ ). Methyl radicals formed in the photolysis of azomethane in solid phase were found to be capable of the following reactions: (1) recombination in the "cell" immediately after formation (formation of  $\text{C}_2\text{H}_6$ ); (2) substitution reactions with molecules of the solvent (formation of  $\text{CH}_4$  and  $\text{R}^\cdot$ , where  $\text{R}^\cdot$  denotes the radical of the solvent); (3) stabilization with emergence from the "cell" (confirmed by the epr spectrum of  $\text{CH}_3^\cdot$  radicals). The ratio of the extent of these three reactions depends on the energy of the absorbed light. Increase of this energy results in an increased formation of methyl radicals reacting according to (2) as compared with those reacting according to (1), and in an increase of methyl radicals reacting according to (3) as compared with those reacting according to (2). The formation of "hot" radicals in the photolysis of  $\text{CH}_3\text{I}$  and  $\text{CH}_3\text{N}_2\text{CH}_3$  in solid phase has thus been clearly proved. The character of the reaction of these "hot" methyl radicals

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S/020/61/140/004/011/023

B106/B110

Reactions of "hot" methyl ...

with molecules of the medium (methyl cyclohexane) depends on structure and bond energies of the molecules decomposing with formation of methyl radicals, and on the wavelength of the light used for decomposition. This effect is obviously related to differences in the type of excitation of "hot" radicals which are formed in different ways. Finally, the authors thank V. V. Voyevodskiy, Corresponding Member AS USSR, for assisting in the evaluation of results, and N. N. Bubnov for recording the epr spectra. The spectrum of the methyl cyclohexyl radical obtained by irradiation of frozen methyl cyclohexane (77°K) with fast electrons was recorded by I. I. Chkheidze in the experimental plant of the Institut khimicheskoy fiziki AN SSSR (Institute of Chemical Physics AS USSR). There are 4 figures, 1 table, and 10 references. 2 Soviet and 8 non-Soviet. The three most important references to English-language publications read as follows: W. C. Sleppy, J. G. Calvert, J. Am. Chem. Soc., 81, 769 (1959); T. Cole, H. O. Pritchard, N. R. Davidson, H. M. McConnell, Mol. Phys., 1, 408 (1958); W. Gordy, C. G. McCormick, J. Am. Chem. Soc., 78, 3243 (1956).

ASSOCIATION: Moskovskiy gosudarstvennyy universitet im. M. V. Lomonosova  
(Moscow State University imeni M. V. Lomonosov)

SUBMITTED: March 24, 1961

Card 4/4

38129  
S/020/62/144/003/026/030  
B124/B101

5.4500

AUTHORS: Shelimov, B. N., Fok, N. V., and Voevodskiy, V. V.,  
Corresponding Member of the AS USSR

TITLE: The benzene-photosensitized low-temperature decomposition  
of hydrocarbons

PERIODICAL: Akademiya nauk SSSR. Doklady, v. 144, no. 3, 1962, 596-599

TEXT: As has been shown earlier, the product from photochemical decomposition of benzene (I), irradiated by ultraviolet light at 77°K in transparent organic glasses is a substituted hexatriene (II)  
 $H_2C=CH-CH=CH-CH=CH-R$  (HR being the hydrocarbon medium in which photolysis is performed), and alkyl radicals are formed in addition. As the formation of alkyl radicals cannot be explained by the reactions hitherto assumed, this and the formation of gaseous products was studied from the epr spectra. Solid-phase reactions of I in methyl cyclohexane (III) and 3-methyl pentane (IV) were studied with concentrations ranging from  $1.8 \cdot 10^{-3}$  to  $2.1 \cdot 10^{-4}$  mole/liter. The mercury vapor lamp WPK-7 (PRK-7) was used as the radiation source. After irradiation, the solution was

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S/020/62/144/003/026/030  
B124/B101

The benzene-photosensitized ...

defrosted, then recooled to 77°K, the gas pressure measured and the gas collected for mass-spectrometric analysis. The irradiated solution was subsequently diluted with n-pentane (V) and the amount of II formed by radiation was measured spectrophotometrically at 275 mμ. The epr spectra of the irradiated solutions of I in III were found to be identical to that of the methyl cyclohexyl radical obtained by radiation of frozen (III), with fast electrons. The spectrum of solutions of I in IV consists of 6 high-resolution, hyperfine structure components with a uniform pattern splitting of about 24 oerst which is probably due to the

$\text{CH}_3\text{-CH}_2\text{-}\overset{\text{CH}_3}{\underset{|}{\text{C}}}\text{-CH}_2\text{-CH}_3$  radical formed by splitting off one H atom from the tertiary C atom of IV. When I is irradiated in IV, H forms, in addition to the R-substituted II, while  $\text{C}_6\text{D}_6$  yields small amounts of HD in addition to  $\text{H}_2$  in the same hydrocarbon. The simultaneous formation of alkyl radicals is obviously due to the decomposition of the hydrocarbon photosensitized by I. The most important feature of the reaction is that the energy of the light quantum absorbed by I (112 kcal/mole) is transferred, all or in part, to the hydrocarbon molecule, which results in splitting

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S/G20/62/144/003/026/030  
B124/B101

The benzene-photosensitized ...

off one C-H bond, whilst the I molecule returns from its excited to the original unexcited state. Neither  $C_6H_5\cdot$ ; ( $C_6D_5\cdot$ ) in the epr spectra nor diphenyl in the reaction products could be detected. Thus, the reaction due to ultraviolet radiation proceeds in two steps: (1) formation of substituted II, and (2) the I-photosensitized decomposition of the hydrocarbon leading to the formation of hydrocarbon radicals and of  $H_2$ . The yields of II and radicals are maximum with I or  $C_6D_6$  concentrations of  $1.6 \cdot 10^{-1}$  and  $6.0 \cdot 10^{-2}$  moles/liter, respectively. The yield of II increases 4.2-fold, when the concentration of I is increased from  $1.8 \cdot 10^{-3}$  to  $1.6 \cdot 10^{-1}$  moles/liter, while the increase of yield of radicals is only 1.2-fold; with  $C_6D_6$ , the relative increase is 2.3 and 1.1 fold. There are 3 figures and 1 table.

ASSOCIATION: Moskovskiy gosudarstvennyy universitet im. M. V. Lomonosova (Moscow State University imeni M. V. Lomonosov); Institut kinetiki i goreniya Sibirskogo otdeleniya Akademii nauk SSSR (Institute of Kinetics and Combustion of the Siberian Department of the Academy of Sciences USSR)

SUBMITTED: February 24, 1962  
Card 3/3.

FOK, N.V., SHELIMOV, B.N., VOYEVODSKIY, V.V.

"On the photosensitized decomposition of hydrocarbons by benzene and its derivatives at low temperature."

Report submitted to the Sixth Intl. Symp. on Free Radicals,  
Cambridge, England 2-5 July 1963

SHELIMOV, B.N.; FOK, N.V.; VOYEVODSKIY, V.V.

Photolysis of ethyl alcohol solutions at 77°K. Kin.i kat. 5  
no.6:1008-1013 N-D '64. (MIRA 18:3)

1. Moskovskiy gosudarstvennyy universitet imeni Lomonosova,  
khimicheskiy fakul'tet i Institut khimicheskoy fiziki AN SSSR.

VINOGRADOVA, V.G.; SHELIMOV, B.N.; FOK, N.V.

Stabilization of atomic hydrogen in the benzene-photosensitized decomposition of hydrocarbons in the presence of silica gel at 77°K. Kin. i kat. 5 no.6:1121 N-D '64.

(MIRA 18:3)

1. Moskovskiy gosudarstvennyy universitet imeni Lomonosova, khimicheskoy fakul'tet i Institut khimicheskoy fiziki AN SSSR.

ACCESSION NR: AP4010761

S/0020/64/154/001/0188/0190

AUTHOR: Vinogradova, V. G.; Shelimov, B. N.; Fok, N. V.; Voyerod-skiy, V. V. (Corresponding member)

TITLE: Photosensitization decomposition of hydrocarbons at low temperatures by benzene derivatives

SOURCE: AN SSSR. Doklady, v. 154, no. 1, 1964, 188-190

TOPIC TAGS: benzene derivative, hydrocarbon, aromatic hydrocarbon, hydrocarbon decomposition, photosensitized decomposition, toluene, ethylbenzene, iso-propylbenzene, p xylene, diphenylmethane, chlorobenzene, triphenylmethane, fluorobenzene, acetophenone, ultraviolet light, o xylene, m xylene

ABSTRACT: Diluted solutions of benzene derivatives, such as toluene, ethylbenzene, iso-propylbenzene, o, m and p-xylene, diphenylmethane, triphenylmethane, fluorobenzene, chlorobenzene and acetophenone in 3-methyl pentane and deuterium-containing 3-methyl pentane were subjected to ultraviolet light at 77 C. Hydrogen was isolated and 3-

Card 1/3

ACCESSION NR: AP4010761

ASSOCIATION: Moskovskiy gosudarstvennyy universitet im. M.V. Lomonosova (Moscow State University), Institut khimicheskoy fiziki, AN SSSR (Institute of Chemical Physics, AN SSSR)

SUBMITTED: 03Sep63

DATE ACQ: 10Feb64

ENCL: 00

SUB CODE: 00

NR REF SOV: 004

OTHER: 011

Card 3/3

ACCESSION NR: AP4010761

methylpentyl radicals were formed in all cases except in  $C_6H_5F$ ,  $C_6H_5Cl$  and  $C_6H_5COCH$  solutions. The initial rate of  $H_2$  evolution was measured and related to the concentration of the triplet state of aromatic molecules. The data agrees with the assumption that molecules of aromatic compounds in the triplet state participate in the photosensitization reaction. The energy of the triplet levels of the aromatic compounds is not higher than 78-85 kcal/mole. The relationship between the rate of the formation of hydrogen and alkyl radicals for toluene and benzene solutions depending on light intensity is investigated and the data are tabulated. The longer life of aromatic molecules in the excited triplet state makes it possible to absorb one more light quantum while passing to the higher triplet level, and owing to the energy excess (as compared to the energy needed to rupture the CH links) causes the photosensitization decomposition of the solvent molecules. Orig. art. has: 1 table.

Card 2/3



ODINTSOVA, S.P.; SHELIMOV, B.N.; FOK, N.V.; VOYEVODSKIY, V.V.

Temperature dependence of the rates of benzene photochemical reactions in hydrocarbon solutions. Izv. AN SSSR. Ser.khim. no.3:572-574 Mr '64. (MIRA 17:4)

1. Moskovskiy gosudarstvennyy universitet im. M.V.Lomonosova i Institut khimicheskoy fiziki AN SSSR.

L 10837-66 EWT(m)/EWP(j) RPL WW/GS/RM

ACC NR: AT5023445

SOURCE CODE: UR/0000/65/000/000/0249/0253

AUTHOR: Shelimov, B. N.; Fok, N. V.; Voyevodskiy, V. V.

ORG: none

TITLE: Benzene and its derivatives in photosensitized hydrocarbon decomposition at low temperatures

SOURCE: Simpozium po elementarnym protsessam khimii vysokikh energiy. Moscow, 1963. Elementarnyye protsessy khimii vysokikh energiy (Elementary processes of the chemistry of high energies); trudy simpoziuma. Moscow, 1965, 249-253

TOPIC TAGS: hydrogen, alkane, aromatic hydrocarbon, UV irradiation, EPR

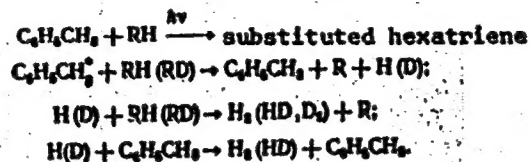
ABSTRACT: Initial rates of formation of hexatriene, alkyl radical, and hydrogen were studied at 77°K as a function of C<sub>6</sub>H<sub>6</sub> and C<sub>6</sub>D<sub>6</sub> concentrations in 3-methylpentane. The dependence of formation rates of hexatriene and hydrogen upon temperature was studied in various solvents using a 2·10<sup>-2</sup> moles/l benzene concentration. All samples were UV irradiated at 77°K. Free radicals were monitored by the EPR technique. The object was to elucidate the mechanism of the simultaneous formation of alkyl radicals and hydrogen during UV irradiation of benzene solutions at 77°K. The hexatriene formation and the photosensitization were not found to be interrelated. The UV irradiation of C<sub>6</sub>H<sub>5</sub>CD<sub>3</sub> in 3-methylpentane at 77°K results in formation of 94% H<sub>2</sub> and 6%

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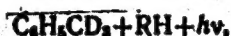
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HD; hydrogen is the sole product when *o*-D- and *p*-D-toluene in 3-methylpentane are subjected to UV irradiation; H<sub>2</sub>, HD, and D<sub>2</sub> resulted from UV irradiation of C<sub>6</sub>H<sub>5</sub>CH<sub>3</sub> in 3-methylpentane. A photosensitized decomposition of hydrocarbons according to the following scheme



occurs in the case of toluene. Results obtained with



system revealed that the rate of formation of C<sub>6</sub>H<sub>5</sub>CH<sub>2</sub> radical is 10-12 times smaller than the rate of formation of alkyl radicals. It was concluded that photosensitized decomposition of hydrocarbons at 77°K also occurs in ethylbenzene, cumene, *o*-, *m*-, and *p*-xylenes, diphenyl- and triphenylmethane and other compounds. Orig. art. has: 1 formula.

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Card 2/2

SHELIMOV, B.N.; FOK, N.V.; VOYEVODSKIY, V.V.

Photochemical decomposition of alcohols at low temperatures.  
Kinetics of methyl alcohol decomposition. Kin. i kat. 4 no.  
4:539-548 JI-Ag '63. (MIRA 16:11)

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